MONTHLY WEATHER REVIEW.

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The MONTHLY WEATHER REVIEW summarizes the current manuscript data received from about 3,500 land stations in the United States and about 1,250 ocean vessels; it also gives the general results of the study of daily weather maps based on telegrams or cablegrams from about 200 North American and 40 European, Asiatic, and oceanic stations.

The hearty interest shown by all observers and correspondents is gratefully recognized.

Acknowledgment is also made of the specific cooperation of the following chiefs of independent, local, or governmental services: R. F. Stupart, Esq., Director of the Meteorological Service of the Dominion of Canada; Señor Manuel E. Pastrana, Director of the Central Meteorological and Magnetic Observatory of Mexico; Camilo A. Gonzales, Director-General of Mexican Telegraphs; Capt. I. S. Kimball, General Superintendent of the United States Life-Saving Service; Commandant Francisco S. Chaves, Director of the Meteorological Service of the Azores, Ponta Delgada, St. Michaels, Azores; W. N. Shaw, Esq., Director Meteorological Office, London; Maxwell Hall, Esq., Government Meteorologist, Kingston, Jamaica; Rev. L. Gangoiti, Director of the Meteorological Observatory of Belen Collegel Havana, Cuba; Luis G. y Carbonell, Director, Meteorologica, Service of Cuba, Havana, Cuba; Rev. José Algué, S. J., Director of the Weather Bureau, Manila Central Observatory, Philippines; Maj. Gen. M. A. Rykachef, Director of the Physical Central Observatory, St. Petersburg, Russia; Carl Ryder, Director, Danish Meteorological Institute, Copenhagen, Denmark.

As far as practicable the time of the seventy-fifth meridian is used in the text of the MONTHLY WEATHER REVIEW.

Barometric pressures, both at land stations and on ocean vessels, whether station pressures or sea-level pressures, are reduced, or assumed to be reduced, to standard gravity, as well as corrected for all instrumental peculiarities, so that they express pressure in the standard international system of measures, namely, by the height of an equivalent column of mercury at 32° Fahrenheit, under the standard force, i. e., apparent gravity at sea level and latitude 45°.

FORECASTS AND WARNINGS.

By Prof. E. B. GARRIOTT, in charge of Forecast Division.

September opened with low barometric pressure and severe gales over the British Isles and the northwestern coasts of continental Europe. Over the Atlantic and Pacific oceans pressure was near the normal. An extensive area of high barometer covered western interior portions of the North American Continent, and a storm area was central near the middle Atlantic coast of the United States. The barometer had risen to 30.18 inches at Vladivostok and pressure was decreasing over the interior of Siberia.

During the first decade of the month there was a gradual tho well-marked change from summer to fall types of atmospheric pressure over the great Asiatic continental area. In the United States barometric movements were as a whole abnormally slow, and resulted in a period of stagnated dry weather over middle and northern districts east of the Rocky Mountains during which forest fires caused considerable damage in localities in the North-Central States, and a serious shortage of water was experienced in many sections.

From the 1st to 3d the Atlantic coast storm moved rapidly northeastward to the Canadian Maritime Provinces, and during the succeeding five days apparently crost the Atlantic in the middle latitudes. From the 2d to 4th the interior American high area moved south of east to the middle Atlantic coast attended by a marked fall in temperature and light frost in the upper Lake region, in mountain districts and in lowlands of the Middle Atlantic and New England States. During the 5th and 6th a shallow barometric depression attended by heavy rains moved rapidly from the Gulf States along the Atlantic coast.

On the morning of the 9th there was evidence of a storm formation near the Leeward Islands of the Lesser Antilles, and during the afternoon and night of that date the center of the disturbance past on a northwesterly course near and to the eastward of Porto Rico. By the morning of the 10th the storm-center had advanced to a position north of Porto Rico, and by the morning of the 11th had past to the westward of Turk's Island, where wind velocities estimated at 80 miles, or more, an hour caused destruction of life and property, Continuing a north-of-west course during the 12th and 13th. the center of the storm recurved northward during the 14th and past to the eastward of Nassau, Bahamas. From this region the disturbance moved northeastward between Bermuda and the American coast during the 15th and 16th, past south of the Canadian Maritime Provinces during the 17th, and disappeared over the Atlantic east of Newfoundland after the 18th, after which it apparently merged into an extensive area of low barometer that extended southward from Iceland.

Beginning the morning of the 10th advices regarding this storm were telegraphed daily until the 15th to Atlantic and Gulf ports. The advices of the 10th stated it would be dangerous for vessels during the next few days in the subtropical region of the Atlantic off the south Atlantic coast of the United States, north of the West Indies, and thence to the longitude of Bermuda. In view of a possible recurve of the storm somewhat farther to the westward than the longitude in which the turn to the northward was actually made, advices urged precautionary measures along the coasts of the Florida Peninsula. The exceptional severity of the storm during its westward passage over the Bahamas and attending its subsequent northeasterly course over the Atlantic is shown by reports of vessels that were caught within its vortex.

A remarkable period of dry weather over the northern half of the United States east of the Rocky Mountains set in during the latter portion of August and continued well into the third decade of September. In two or three instances during this period indications that as a rule presage rain partially or wholly failed. The rather remote causes of the dry spell are now recognized. It was not possible to detect and interpret them with previous imperfect knowledge of the operative influence of the greater barometric areas. On September 22d the following forecast based upon radical changes in pressure was issued:

A barometric disturbance will cross the country from about the 24th to 28th, attended by rains that will set in over the central valleys about

the close of this week and extend over the Atlantic States by the beginning of next week. Following the rains there will be a sharp fall in temperature, with frost in the central valleys and Eastern States north of the fortieth parallel.

The rains that attended this disturbance occurred as forecast and relieved the drought in northern and northeastern districts. The frosts that followed its passage extended over the Middle Western States and the States of the Ohio Valley and middle Atlantic coast.

The following comment on this storm and cool wave is made by the Market Growers Journal, Louisville, Ky., of September 30, 1908:

A general area of rain set in over practically the entire Rocky Mountain region the latter half of the week and moved gradually eastward, bringing rain to the Mississippi Valley States by Saturday night. The rain reached the Ohio Valley Sunday night of this week and the indications at this writing are that before this issue reaches our readers the drought in all sections of the country which have been suffering will have been brought to an end. An interesting fact of this rain period is that it was predicted early last week in a bulletin sent out by the Weather Bureau at Washington. * * * The general rains, which marked the end of the drought, are being followed by a period of cold weather which will mark the end of the unusually warm weather of September.

An editorial in the Albany, N. Y., Journal of September 29, reads as follows:

Just now there is in evidence the fulfilment of a forecast made a week ago. Early last week it was announced from Washington that conditions were favorable for the development of a general rain area in this part of the country by about the 28th instant. Because of the long absence of rain that prediction was of unusual interest, and the arrival of the time appointed for its fulfilment was awaited with mingled hope and apprehension.

There was a widespread feeling of relief when the sky became overcast and precipitation began, gradually as it nearly always does after a long period of dry weather.

The Weather Bureau is to be congratulated upon the accuracy of a "long distance" forecast, made at a critical time when all ordinary signs, even to that old standby, the sun's "crossing the line," seemed to fail.

The Kansas City, Mo., Star of September 27, remarks as follows:

An interesting fact about the storm area that is now moving across the country is that it was accurately predicted by the Weather Bureau last Tuesday evening (September 22), when a "long distance" forecast was put out saying that rains would fall in the central valleys about the close of this week, and in the Atlantic States at the beginning of next week, followed by frost north of the fortieth parallel.

The Weather Bureau's forecasts for a week ahead are still in the experimental stage, but they promise to be of great value. They are based on reports of barometric pressures in various parts of the world, indicating the progress of storm areas. Last Tuesday's forecast was based on reports of low barometric pressure at the time in Nome and Sitka, Alaska, and in Honolulu. But the present storm area first appeared over the Rocky Mountain regions with a bank of high barometer all week along the Pacific coast, so that it seems questionable as to whether it came from the conditions on which the Weather Bureau based its long distance forecast of last Tuesday.

The forecast was based on reports for several days preceding the date of its issue. On September 17 Pacific pressure was high over Honolulu and low over Nome. Three days later pressure was high over the Bering Sea region and low over the Hawaiian Islands. It has been observed that pressure changes over the Pacific Ocean forerun by several days certain changes on the Pacific coast and the American Continent as a whole. On September 23 a decided fall in the barometer occurred over the middle and south Pacific coast districts, and on the following day the barometric disturbance appeared, as stated, over the Rocky Mountain districts. It is true that pressure continued high over the north Pacific coast. That was expected. The predictions are based, not necessarily upon the progress of individual storm and high barometer areas, but upon a study of atmospheric conditions over the whole Northern Hemisphere, and more directly, at this season of the year, on the general circulation of the atmosphere over the Pacific and Atlantic oceans. In winter the great continental areas of high barometer, and more especially the Asiatic high area, appear to dominate the general atmospheric changes of the Northern Hemisphere. By a study of the association and interrelation of the greater areas of high and low barometric pressure is the forecasting of weather changes for a week, or more, in advance made possible.

On September 24 West Indian stations were advised of the presence of a cyclonic disturbance east of the Lesser Antilles in latitude about 15° north. On the following morning West Indian ports and Atlantic and Gulf shipping interests were informed that a disturbance of marked intensity near the Leeward Islands of the Lesser Antilles was moving in a westerly direction. During the succeeding two days the hurricane center moved on a west-northwest course, and at 6 a. m. of the 28th past near Port au Prince, Haiti, with a reported minimum barometer reading at that place of 29.24 inches. Continuing a west-northwest course the vortex of the storm advanced over or near the Great Bahama Bank by the close of the month and recurved thence northward over the western Bahamas by October 1, with reported minimum barometric pressure 28.68 inches at 10 a. m., and wind exceeding 80 miles an hour from the south at Nassau. Assuming a northeasterly course the storm then advanced over the Atlantic in the direction of Bermuda. Further advices that may become available regarding this storm will be given in the October, 1908, MONTHLY WEATHER REVIEW.

It is interesting to note that during the present season three West Indian hurricanes have occurred simultaneously with typhoons in Asiatic waters. In the third decade of July a destructive typhoon struck Hongkong, and a severe storm that had its origin in the Caribbean Sea moved northward along the Atlantic coast of the United States. In the second decade of September a typhoon advanced from the Philippine Islands northward along the eastern Asiatic coast, and a hurricane devastated the eastern islands of the Bahama group, moving thence northeastward. In the third decade of September a hurricane swept west-northwest from the Lesser Antilles to the western Bahamas and recurved thence northeastward, and a typhoon past from the Philippine Islands westward over the China Sea.

BOSTON FORECAST DISTRICT.*
[New England.]

The month was unusually warm and dry. The drought that prevailed was one of the most severe in many years, particularly in Vermont, and the average rainfall for New England was the smallest for September since the establishment of the New England Climatological Service in 1888. The first killing frost of the season occurred in Maine, New Hampshire, Vermont, and parts of Massachusetts on the 16th. Frost warnings were sent to cranberry growers on the 15th. Storm warnings were issued on the 1st, 17th, and 28th, and there were no storms without warnings.—*J. W. Smith, District Forecaster.*

NEW ORLEANS FORECAST DISTRICT.*
[Louisiana, Texas, Oklahoma, and Arkansas.]

A disturbance for which storm warnings were ordered appeared in the west Gulf the morning of the 17th. This disturbance was attended by a wind velocity of 64 miles an hour at Galveston, Tex., and by general showers over Louisiana, eastern Texas, Oklahoma, and Arkansas. The first frost of the season was reported in Oklahoma and northeastern Texas on the 28th, for most of which warnings had been issued.—*I. M. Cline, District Forecaster.*

LOUISVILLE FORECAST DISTRICT.*
[Kentucky and Tennessee.]

The month was remarkable on account of the severe drought and unusual warmth that prevailed, except in southeastern Tennessee where rainfall was about normal. Over the balance of Kentucky and Tennessee practically no rain fell from the

5th to 27th. A decided change to colder came with the rainstorm of the 27th, and the last three days of the month were unusually cold, with frost generally in Kentucky and parts of Tennessee. Special warnings were issued for the frost.—*F. J. Walz, District Forecaster.*

CHICAGO FORECAST DISTRICT.*

[Indiana, Illinois, Michigan, Wisconsin, Minnesota, Iowa, Missouri, North Dakota, South Dakota, Nebraska, Kansas, and Montana.]

Except during the last few days of the month September was unusually warm. The change to cooler weather set in over the Western States on the 25th and advanced slowly eastward, bringing unseasonably cold weather and general frosts for which warnings were issued well in advance. Frost warnings were again issued on the 30th in advance of another cool area. Special frost warnings were issued to the cranberry marshes of Wisconsin on the 1st, 2d, and 6th, and in each case frost and freezing temperatures were reported in the bogs. The drought conditions continued from the previous summer months, and they were not effectually broken until the passage of the storm of the last week. The only disturbance that justified storm warnings crost the upper Lakes on the 30th, and warnings were issued for this storm on the morning of that day.

The following action was taken by the South Dakota State Board of Agriculture in connection with a special forecast telegraphed from Chicago to the Local Office of the Weather Bureau at Huron, S. Dak., on September 8:

By resolution of the State Board of Agriculture, it is my duty and pleasure to express to you, and through you to the U. S. Weather Bureau, our sin ere thanks for the long forecast given us for the week of our Fair. It was of great value for us to know this as it saved much expense in preparing for rain as we felt we should. Besides this it was a great relief of mind to the management to know that we could expect such fine weather. J. W. CAMPBELL, *President,*

H. J. Cox, Professor and District Forecaster.

DENVER FORECAST DISTRICT.*

[Wyoming, Colorado, Utah, New Mexico, and Arizona.]

Except during the closing week the month was warm and dry. From the 23d to 26th a heavy storm of snow and rain moved from Wyoming to southern New Mexico. The storm was followed by one of the most severe cold spells on record during September in eastern portions of Wyoming, Colorado, and New Mexico. Timely warnings of frost and freezing temperature were issued in connection with the cold spell.—*P. McDonough, Local Forecaster, temporarily in charge.*

SAN FRANCISCO FORECAST DISTRICT.†

[California and Nevada.]

The most striking feature of the month was the storm that prevailed over southern California on the 23d to 25th. Generally speaking the rainfall was the heaviest during September since records have been kept. It varied in amount from half an inch to several inches. The raisin-making section had ample warnings of the rains and the benefit of the service has been acknowledged. No frost nor storm warnings were issued during the month.—*A. G. McAdie, Professor and District Forecaster.*

PORTLAND, OREG., FORECAST DISTRICT.†

[Oregon, Washington, and Idaho.]

The month was unusually dry in western and northern sections, and temperature was slightly above normal east of the Cascade Mountains. A moderate disturbance crost the northern portion of the district the last day of the month. Light frosts occurred on the 23d and 24th and heavy frosts on the 25th and 26th. Warnings of the storm and frosts were issued in time to be of service to those interested in them.—*E. A. Beals, District Forecaster.*

RIVERS AND FLOODS.

The feature of the month was the general drought that prevailed over the middle and northern districts east of the Rocky Mountains. Little or no rain fell over this extensive area until the end of the month, and all streams, except the Mississippi and Missouri, were at very low stages. The two larger rivers were not lower than usual for the season of the year.

The drought conditions were most severe in the Ohio Valley and the Middle Atlantic States, and in many places rivers were lower than ever before. Navigation was practically suspended on the Ohio, and many manufacturing plants in the upper Ohio Valley were compelled to suspend operations on account of lack of water.

Delayed reports of the flood of August and early September in the rivers of eastern South Carolina show that the damage caused thereby amounted to over $900,000, divided as follows: Property loss, excluding crops, $200,000; losses of crops, $700,000. The losses due to erosion of land and suspension of business were reported great, but detailed reports were not available.

The highest and lowest water, mean stage, and monthly range at 211 river stations are given in Table IV. Hydrographs for typical points on seven principal rivers are shown on Chart I. The stations selected for charting are Keokuk, St. Louis, Memphis, Vicksburg, and New Orleans, on the Mississippi; Cincinnati and Cairo, on the Ohio; Nashville, on the Cumberland; Johnsonville, on the Tennessee; Kansas City, on the Missouri; Little Rock, on the Arkansas; and Shreveport, on the Red.—*H. C. Frankenfield, Professor of Meteorology.*

* Morning forecasts made at district center; night forecasts made at Washington, D. C.

† Morning and night forecasts made at district center.

SPECIAL ARTICLES, NOTES, AND EXTRACTS.

RÉSUMÉ OF EXPERIMENTS IN AERODYNAMICS

By Dr. A. F. ZAHM. Dated Washington, D. C., August 24, 1908.

INTRODUCTION.

Aerodynamics may be defined broadly as the science of motion of air, or an aeriform fluid. Commonly air alone is implied in the word. This is especially true when the name is used by engineers. With them it is the analog of hydraulics, which is the science of motion of water. Both sciences treat not only of the movement of their peculiar media, but also of its effects on objects, or machinery, connected with the fluids.

An important function of aerodynamics is to determine the velocity and stress of air at every point of this medium, when it flows past an obstacle, the physical conditions of the fluid being given or observed by means of suitable instruments. From the point-velocity the stream-lines may be mapped; from the point-stress about an object the resultant pressure and friction may be found by integrating over its surface.

Equivalent results may be obtained if the object move against the fluid, since only the relative motion is of consequence. Devices are in use, also, for revealing these integrated effects directly, without first finding the point-velocity and point-stress. Some of these will be described presently.

Experimental aerodynamics may be studied in its elements, as distinguished from its applications, by considering it under these heads: (1) velocity and stream-lines; (2) normal stress and resultant pressure; (3) shearing stress and resultant friction; (4) combined pressure and friction. To trace the development of even this much of the science would require a large volume.

The following pages present a brief sketch of such of the writer's experiments as may be classed under the above heads,